Refined trends in poaching for West Coast rock lobster based upon information from the DAFF compliance "new" database for the period 2012 to 2017, and final poaching trends used for updated assessments and projections

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Abstract

GLM methods are applied to the DAFF "new" compliance database in which policing effort is linked to confiscations taken as well as to the "old" compliance database on confiscations (and abandonments) and on policing effort (but restricting the analyses to policing effort types that are common with the "new" database) to estimate recent trends in the amount of rock lobster that is poached. GLM methods are also applied to this "old" database, but estimates of relative effort efficiencies for different effort types obtained from the "new" database (and adjusted to account for inspections with zero confiscations which are not recorded in the "new" database) are used to link effort to the number of confiscations to provide a refined "old"-linked time series for the level of poaching. Because the number of data in the "new" database is so much less (only some 0.5%) than in the "old" database, it was decided that the "new" database analyses be used only to provide estimates of relative efficiency of different effort types, and that the "old"-linked series serve as the basis for the assumptions concerning poaching needed for future assessments. This document finally reports the basis underlying the selected Base Case and two sensitivities for poaching estimates and trends developed by the WCRL Task Group (TG) which was appointed for that purpose. The TG's proposals were based on analyses of both DAFF Compliance data and import-export data compiled by TRAFFIC, which were used for updated assessments and projections of the resource.

Introduction

At the 2017 IWS meeting, analyses were presented that estimated poaching trends for west coast rock lobster. These analyses were based on data on the number of monthly confiscations and policing effort obtained from one of the Directorates within the CD (Directorate: Compliance). A major problem for analyses using these data is that the confiscations are not linked to a particular policing effort.

The 2017 panel was requested to comment on the following: "For the data [DAFF compliance] available, how might the analysis methods being used be improved? An extract of their comments and recommendations (in bold follows below):

> *Although the current GLM approach to analysing the effort data is broadly sound in principle, it relies on the tenuous assumption that the efficiency ("q") for each enforcement type is roughly the same. ... Unfortunately, information provided by Compliance to the Panel suggests that this is not the case. Moreover, the trend in effort for enforcement types with low average effort (which are down-weighted in the current analysis approach) differs from trends in high and average effort enforcement types.* ***Efforts for the various enforcement methods need to be corrected for their variable efficiency before being combined into an overall effort index. This efficiency should be estimated using all available information (quantitative and qualitative), and the analysis rerun using the original GLM procedures presented to the Panel.*** *...* ***The Panel strongly recommends that there be ongoing efforts to link confiscations to the enforcement method, and the resultant information provided to analysts to improve future monitoring of poaching.***

Upon further discussions with DAFF Compliance, it came to light that there were in fact records available that linked confiscations to policing effort type. This paper gives results for the tasks listed below to analyse poaching trends given the "old" (confiscations not linked to the type of policing) and the "new" (confiscations linked to policing effort type) databases, and incorporating the recommendations from the Panel. The tasks were:

i) Update the poaching analyses as before using the updated "old" database.
ii) Run an analysis on the "new database" to obtain results for the poaching trend – this will also provide the relative efficiencies of the different policing effort types.
iii) Rerun analysis on the "old" database but now using the relative effort efficiencies estimated in ii).
iv) Compare the overall "trends" between i), ii) and iii).

Not all policing effort types match between the "new" and the "old" databases. Further, because of the scarcity of data for all policing types in the "new" database, some policing effort types were combined if they were deemed to be of a similar type and some were omitted from any analyses. The policing effort types in the "new" database available for possible analyses were slipway inspections, coastal patrols, Tip Offs, Joint Ops and vehicular inspections (VCP's). Also to be able to apply the estimated relative policing effort efficiencies from the "new" database to the "old" data, common policing efforts were needed. These were chosen to be slipway inspections, coastal patrols and vehicle inspections (VCP's) on the advice of D van Zyl.

The document concludes by combining the results obtained with import/export information from TRAFFIC to provide the estimates of magnitude and trends in rock lobster poaching which were used in updated assessments and projections of the resource.

Data

Monthly data on confiscations and policing effort obtained from one of the Directorates within the CD (Directorate: Compliance) for the period of April 2008 to December 2017 form the "old" database are used in the present analyses, as are data for the period 2012 to 2017 on rock lobster confiscations that are linked to a policing effort type form the "new" database. The first three months of the 2016 compliance data have been omitted from the analyses to remove the effect of the greatly enhanced policing levels during those months when Operation Phakisa was launched.

Methods

For the "old" data for which confiscations are **not linked** to policing effort, Generalized Linear Models (GLMs) were used to investigate the variation in the number of confiscations of rock lobster as well as that in the policing effort that has occurred. (Note that "year" refers to a calendar year throughout this document.)

The expected policing effort was modelled as:

$$\mathrm{E}(P) = \exp\left(\mu + \alpha_{month} + \beta_{type} + \delta_{year}\right) \quad (1)$$

where

P is the policing effort, assumed to have an overdispersed Poisson distribution,

μ is the intercept,

α_{month} is the month effect,

β_{type} is the type of policing effect, where the "type" factor is associated with the different types of policing that are common to both the "old" and the "new" data; these are coastal patrols, slipway inspections, and vehicles inspections, and

δ_{year} is the year effect (2008 to 2017).

A weight was applied to each of the GLMs above to account for different levels of variance (beyond Poisson) in the data for the different measures of policing. The weight applied to the data is given by the inverse of the estimated overdispersion parameter obtained by fitting a similar GLM to that of Equation (1) (without the "type" factor and assuming a linear relationship with time instead) to each separate data set for the different types of policing employed.

The same procedure as for policing effort was applied to the number of confiscations. The one difference in the GLMs is that the β_{type} effect did not apply in this case. There was no weighting of the data in these confiscations.

For the "new" data for which confiscations are **linked** to the policing effort type, poaching trends were obtained from the number of confiscations adjusted by the policing effort as set out below.

The expected number of confiscations was modelled as (task (ii)):

$$\mathrm{E}(C_{new}) = \exp\left(\mu + \alpha_{month} + \beta_{type} + \delta_{year}\right) \quad (2)$$

where

C_{new} is the number of confiscations made in a single compliance event, assumed to have an overdispersed Poisson distribution (though this overlooks the complication that the new database does not include instances where no confiscations occurred),

μ is the intercept,

α_{month} is the month effect,

β_{type} is the type of policing effect which is linked to the confiscations, where the "type" factor is associated with the different types of policing such as coastal patrols, slipway inspections and vehicles inspections, and

δ_{year} is the year effect (2012 to 2017).

Note that effort "type" appears here only in the form of a single value. This is because unlike, in the GLMs for the "old" data where confiscations and effort are summed over each month in each year, here each event was treated as a separate datum entered into the analysis.

From the GLM for the "new" database, the estimates of the β_{type} effect value provide relative policing effort efficiencies which can be used in re-analysing the "old" database (task (iii)). However, these relative efficiencies of the different compliance effort types needed to be adjusted to account for the absences of inspections with zero rock lobster confiscations in the "new" database. The adjustments effected were the averages over years of proportions of successful (illegally caught rock lobster confiscated) inspections as given in Table 1.

The policing effort (*E*) for the "old" database that is linked to the number of confiscations was obtained by multiplying the policing effort value by its adjusted efficiency as determined in task (ii) and adding over all the effort types. Poaching trends for the "old" linked database were then obtained from the δ_{year} values using the model:

$$\mathrm{E}(C_{old}) = E\exp\left(\mu + \alpha_{month} + \delta_{year}\right). \quad (3)$$

Results and Discussion of analysis of compliance data

Results are restricted to the northern and southern areas division of the west coast rock lobster. Tables 2a and 3a show the parameter estimates for the GLMs fitted to the "new" database and to the "old" database confiscation data but linked to effort by using the estimates of relative effort efficiencies obtained from the GLM of the "new" data for Super-areas 3+4+5+6+7 and 8+ respectively. Tables 2b and 3b show the relative efficiencies of different types of policing effort after adjusting for the proportion of inspections which were successful in confiscating illegally caught lobster. Figure 1 shows the poaching trends obtained from the "new" database and compares these to those obtained from the "old" database and from the GLM for the "old" database in which the

relative effort efficiency estimates from the "new" database GLM are applied to the policing effort data for these Super-area combinations.

The poaching trends obtained from the "old" database, and from the "old" database that has used estimates of relative effort efficiencies obtained from the "new" database, show broadly similar patterns for all the Super-areas considered (Figure 1). The poaching trends obtained from the "new" database for the northern Super-areas (3-7) differ in the main in the last one or two years, but note the large associated confidence intervals (plots in Figure 1 in the middle – a consequence of the much lower number of entries in the new compared to the "old" database – see Table 4). For the southern Super-area 8+ (Figure 1) the "new" estimated poaching trends are more variable than the "old" – again likely the result of smaller sample sizes.

While in due course the quantity of data recorded in the new database should increase to a level where it can be used as the primary basis to estimate poaching trends, at present this quantity seems too small (Table 4) for these data (at present only about 0.5% as numerous as the "old" data) to be deemed to provide sufficiently reliable inferences for these trends. We therefore advocate that the "old"-linked trends shown in Figure 1, which adjust earlier analyses for the relative efficiencies of different poaching types, should serve as the primary basis for inferring poaching trends. These do suggest some downturn in the last two years in the northern area, but seem to vary about a steady level from 2013 onwards for Super-area 8+.

Figure 2 and Tables 5a-b compare these trends to the results used two years ago, together with how they were smoothed for use in the base case assessment at that time. Importantly, because results here are shown relative to 2008 (for Super-area 8+) or 2009 (for the northern area), the relative levels of poaching since that time are notably **higher** for the "old"-linked trends than indicated two years ago. This "normalisation" relative to 2008/9 merits further discussion. Note that confidence intervals relative to 2014 for the "old"-linked annual estimates of poaching are shown in the right side panels of Figure 1.

The way these results were used in updating estimates of poaching trends is described in the following section.

Final developments of poaching trends and absolute poaching amounts

The Task Group agreed to develop two poaching trends, one ("Compliance" scenario) based on the trends indicated by the compliance data analyses, and one based on the trend indicated by the TRAFFIC data ("TRAFFIC" scenario).

A) **NORTH : SOUTH SPLIT in 2008 (A3-7 : A8+)** [*unchanged from specification in 2016*]

North : South in 2008: 30 : 70

The relative splits of poaching in the North area amongst A3+4, A5+6 and A7 remain as previously, and are (as a % of poaching in the North):

A3+4: 37.5% (i.e. in 2008 11.25% of total)

A5+6: 37.5% (i.e. in 2008 11.25% of total)

A7: 25.0% (i.e. in 2008 7.5% of total)

B) TREND: Relative to 2008=1.0 for "Compliance" scenario [*virtually unchanged from specification in 2016*]

Pre-1990	0.5 in 1990 decreasing linearly to zero in 1950
1990 – 2008	0.5 (in 1990) → 1.0 (in 2008)

North: 2008 = 1.0; 2009=1.0; 2012=0.3; 2014=0.5; 2017=0.2

South: 2008=1.0; 2012=2.0; 2015=4.0; 2017=4.0

Figure 2 shows the final estimates of trends in poaching from the DAFF compliance data for both the North (A3-7) and South (A8+) based on the "old-linked" series. Similarly to 2016, the TG proposed use of smoothed trend summaries of those estimates which are shown by the dotted lines in Figure 2; those lines reflect linear trends between the break-points listed above. The compliance data provide no information on any trend from 2008 to 2009 for the North, but it is convenient for calculation purposes to assume those two values to be identical.

C) TREND: Relative to 2000=1 for "TRAFFIC" scenario (inferred from TRAFFIC reports)

Pre-1985	0.67 in 1985 decreasing linearly to zero in 1950
1985 – 2000	0.67 (in 1985) → 1.0 (in 2000)
2000 – 2017	1.0 (i.e. unchanged throughout this period)

Figure 3b (informed by Figure 3a) shows these trend values (relative to 2000=1.0).

D) TREND: 2018+

The default assumption is that the 2018+ values are the same as for 2017 [*similar to specification in 2016*]

E) ABSOLUTE VALUES

Figure 3a (taken from TRAFFIC's document (FISHERIES/2018/JUL/SWG/WCRL11) informed on the absolute (rounded) poaching figure of 900 tons from 2000+.

The TRAFFIC data (2000+) suggest an annual average (rounded) value of 900 tons

TRAFFIC scenario: 900 tons in 2012 (and the same each year from 2000 to 2017)

Compliance scenario: 900 tons in 2012 (and for other years consistent with the trend and area-split information above; this corresponds to 604 tons in 2008).

Results for poaching trends and absolute estimates

Figures 4 and 5 plot the absolute poaching trends associated with the Compliance scenario (Figure 4) and the TRAFFIC scenario (Figure 5) that follow from the above, as agreed by the TG. Figure 6 compares these two trends for the North and South areas combined.

The results in Figure 6 are clearly different for the two scenarios. The TG agreed that neither would reflect the true situation: the TRAFFIC scenario fails to take account of likely growing illegal sales on the local market, whereas the Compliance scenario may be more reflective of that local trend than of the trend for all the components of the illegal catch.

The TG therefore considered that reality likely lies between the two scenarios shown in Figure 6, and that they needed to be weighted to provide a more realistic result. The majority of the TG favoured giving a 75% weighting to the Compliance scenario, but there was a minority view that it should receive only a 25% weighting. The TG consequently agreed on a Base Case (BC) time series and a Sensitivity to that as shown below for use in updating assessments:

BC:	Gives 75% weight to the compliance trend and 25% weight to the TRAFFIC trend.
Sensitivity 1:	Gives 25% weight to the compliance trend and 75% weight to the TRAFFIC trend.

Figure 7 plots these two (BC and Sensitivity 1) trends.

Furthermore, in the light of arguments put forward relating to the interpretation of the TRAFFIC data, the TG agreed to a further Sensitivity (Sensitivity 2) which replaces the 900 ton absolute take value used to develop the original two Scenarios by 700 tons, by down-scaling all BC values by the ratio 700/900. This is also shown in Figure 7. The rationale given for this was that he 900 MT IUU estimate is based, amongst other factors, on the assumption in TRAFFIC's analyses that 96% of the frozen product imported from South Africa comprises frozen tails and should be converted to whole green weight by the South Coast rock lobster conversion factor of 2.22. Additional data sources show that a materially significant amount of the imported frozen product comprises whole frozen West Coast rock lobsters. Therefore, a certain amount of the product which is being converted to whole product is actually already whole product. Based on available export information for legally caught and exported whole frozen West Coast rock lobster, and an assumed figure for the IUU component not reflected in official records, the undue additional IUU tonnage estimated via TRAFFIC's methods is approximately 200 MT. This estimate corrects for the assumption that imported frozen product comprises 96% and not 100% frozen tails. This suggests that the 900 MT IUU catch estimate should rather be 700 MT.

Values for certain years for the BC and two sensitivity proposals are set out in Tables 6 and 7.

Reference

Oakes, N. and Burgener, M. 2018. Estimating the discrepancy between world reported imports and South African landings data for rock lobster, 2000-2017. TRAFFIC document. FIAHERIES/2018/AUG/SWG-WCRL/27.

Table 1. Difference between the number of observations in the "old" and the "new" databases that might be assumed to be the number of "zero" confiscations in the "new" database. Results are shown by common policing effort types and Super-areas. The percentage of observations in the "new" database that would constitute non-zero confiscations are also shown.

	Difference in number of observations between "old" and "new"			**Percentage of observations that would constitute non-zero confiscations in the "new" database**		
Northern Super-areas 3+4+5+6+7						
	Coastal Patrols	Slipway inspections	Vehicle inspections	Coastal Patrols	Slipway inspections	Vehicle inspections
2008	—	—	—	—	—	—
2009	1822	1939	3724	—	—	—
2010	2510	3287	3587	—	—	—
2011	3223	4197	3953	—	—	—
2012	2935	3537	7068	0.17%	0.00%	0.24%
2013	2513	2902	6464	0.28%	0.68%	0.68%
2014	2646	2726	4174	0.94%	1.30%	0.69%
2015	2742	2997	3551	0.47%	1.12%	0.84%
2016	2623	3134	2442	0.57%	0.22%	0.12%
2017	2548	2781	1841	0.78%	0.36%	0.22%
Average	***2618***	***3056***	***4089***	***0.54%***	***0.61%***	***0.47%***
Southern Super-area 8+						
2008	3923	2585	3179	—	—	—
2009	4857	3766	3951	—	—	—
2010	5540	3507	3847	—	—	—
2011	7722	4876	2604	—	—	—
2012	5991	4547	3366	0.02%	0.57%	0.03%
2013	4931	4291	2966	0.78%	0.44%	0.00%
2014	4208	3848	1806	0.82%	0.67%	0.06%
2015	5656	4621	2593	0.88%	0.75%	0.04%
2016	5579	3661	3539	0.46%	0.97%	0.06%
2017	6161	4534	4567	0.63%	0.74%	0.00%
Average	***5457***	***4024***	***3242***	***0.60%***	***0.69%***	***0.03%***

Table 2a. GLM parameter/coefficient (and standard error) estimates for Super-areas 3+4+5+6+7.

	Poaching ("new")	Poaching ("old"-linked)
January	0	0
February	1.300 (0.684)	0.848 (0.365)
March	0.819 (0.772)	1.077 (0.329)
April	0.442 (0.760)	0.214 (0.359)
May	0.780 (1.060)	-0.038 (0.379)
June	0.043 (1.312)	-2.928 (1.278)
July	-0.725 (2.247)	-3.141 (1.239)
August	-0.365 (3.248)	-2.477 (0.773)
September	0.998 (1.169)	-1.231 (0.628)
October	1.519 (0.726)	-2.163 (0.720)
November	-1.490 (1.417)	-1.351 (0.478)
December	1.326 (0.665)	0.194 (0.361)
2008	—	—
2009	—	0.409 (0.383)
2010	—	1.225 (0.320)
2011	—	0.142 (0.363)
2012	-1.620 (1.044)	-0.835 (0.420)
2013	-1.044 (0.593)	-0.594 (0.407)
2014	0	0
2015	-0.094 (0.408)	0.084 (0.373)
2016	-1.203 (1.531)	-1.350 (0.950)
2017	0.401 (0.490)	-1.063 (0.558)
coastal	0	—
slipway	0.611 (0.568)	—
vehicles	1.013 (0.571)	—

Table 2b. Relative efficiencies of different types of policing effort after adjusting for the proportion of inspections which were successful in confiscating illegally caught lobster for Super-areas 3+4+5+6+7.

Policing effort type	Adjusted relative efficiency
Coastal	1.000
Slipway	2.155
Vehicles	2.390

Table 3a. GLM parameter/coefficient (and standard error) estimates for Super-area 8+.

	Poaching ("new")	Poaching ("old"-linked)
January	0	0
February	1.547 (0.423)	1.152 (0.433)
March	0.272 (0.682)	-1.099 (0.791)
April	-1.102 (0.715)	0.571 (0.463)
May	-0.250 (0.667)	0.140 (0.514)
June	0.339 (0.629)	-0.119 (0.535)
July	-0.619 (1.493)	-1.278 (0.739)
August	-1.333 (1.936)	-2.983 (1.391)
September	2.400 (0.520)	-0.086 (0.531)
October	-1.380 (2.410)	-0.729 (0.613)
November	-0.993 (0.858)	-1.223 (0.746)
December	-2.310 (0.971)	-0.582 (0.589)
2008	—	-1.223 (0.812)
2009	—	-1.137 (0.696)
2010	—	-0.595 (0.549)
2011	—	-0.113 (0.487)
2012	-1.012 (1.417)	-1.033 (0.626)
2013	1.206 (0.474)	0.750 (0.424)
2014	0	0
2015	0.988 (0.431)	0.090 (0.456)
2016	-0.073 (0.686)	0.673 (0.478)
2017	-0.953 (0.782)	0.070 (0.452)
coastal	0	—
slipway	-0.357 (0.314)	—
vehicles	3.032 (0.596)	—

Table 3b. Relative efficiencies of different types of policing effort after adjusting for the proportion of inspections which were successful in confiscating illegally caught lobster for Super-area 8+.

Policing effort type	Adjusted relative efficiency
Coastal	1.000
Slipway	0.805
Vehicles	1.037

Table 4. Number of observations in the "old" and the "new" databases available for analyses.

	"Old" database	"New" database
2008	9687	—
2009	20059	—
2010	22278	—
2011	26575	—
2012	27494	50
2013	24196	129
2014	19560	152
2015	22323	163
2016	21067	89
2017	22539	107

Table 5a. Poaching series obtained from the "old" database and the "old" database using relative effort efficiencies from the "new" database model ("old"-linked) and the "previous" series assumed for the 2016 assessment and projections for the northern Super-areas 3+4+5+6+7.

	Previous	"Old"	"Old"-linked
2008	—	—	—
2009	1.000	1.000	1.000
2010	0.767	0.918	2.262
2011	0.533	0.355	0.766
2012	0.300	0.216	0.288
2013	0.367	0.288	0.367
2014	0.433	0.403	0.664
2015	0.500	0.356	0.722
2016	0.500	0.074	0.172
2017	0.500	0.113	0.229

Table 5b. Poaching series obtained from the "old" database and the "old" database using relative effort efficiencies from the "new" database model ("old"-linked) and the "previous" series assumed for the 2016 assessment and projections for the southern Super-area 8+.

	Previous	"Old"	"Old"-linked
2008	1.000	1.000	1.000
2009	1.250	0.837	1.090
2010	1.500	1.673	1.874
2011	1.750	2.070	3.033
2012	2.000	0.978	1.209
2013	2.667	5.084	7.189
2014	3.333	2.883	3.396
2015	4.000	3.149	3.715
2016	4.000	5.566	6.657
2017	4.000	3.035	3.642

Table 6. Poaching amounts for the North, South and Total resource for the two different data sources. The values shown bolded are the inputs to which the trends developed are then applied to give absolute values for each year.

	Compliance scenario			**TRAFFIC scenario**		
	Total	**North**	**South**	**Total**	**North**	**South**
1950	0	0	0	0	0	0
1985				**600**	180	420
1990	302 (0.5*2008)	91 (0.5*2008)	211 (0.5* 2008)	700	210	490
2000				**900**	270	630
2008	**604**	**181**	**423**	**900**	**270**	**630**
2012	**900**	54 (0.3*2008)	846 (2 * 2008)	**900**	270	630
2014	1274	91 (0.5*2008)		**900**	270	630
2015			1691 (4*2008)			
2017+	1727	36 (0.2*2008)	1691 (4*2008)	**900**	270	630

Table 7. Poaching amounts for the Total resource for the Base Case and two sensitivity proposals.

	Base Case	**Sensitivity 1**	**Sensitivity 2**
1950	0	0	0
1985	348	516	271
1990	402	601	312
2000	556	785	432
2008	678	826	527
2012	**900**	**900**	**700**
2014	1350	1050	1050
2015	1546	1115	1202
2017+	1521	1107	1183

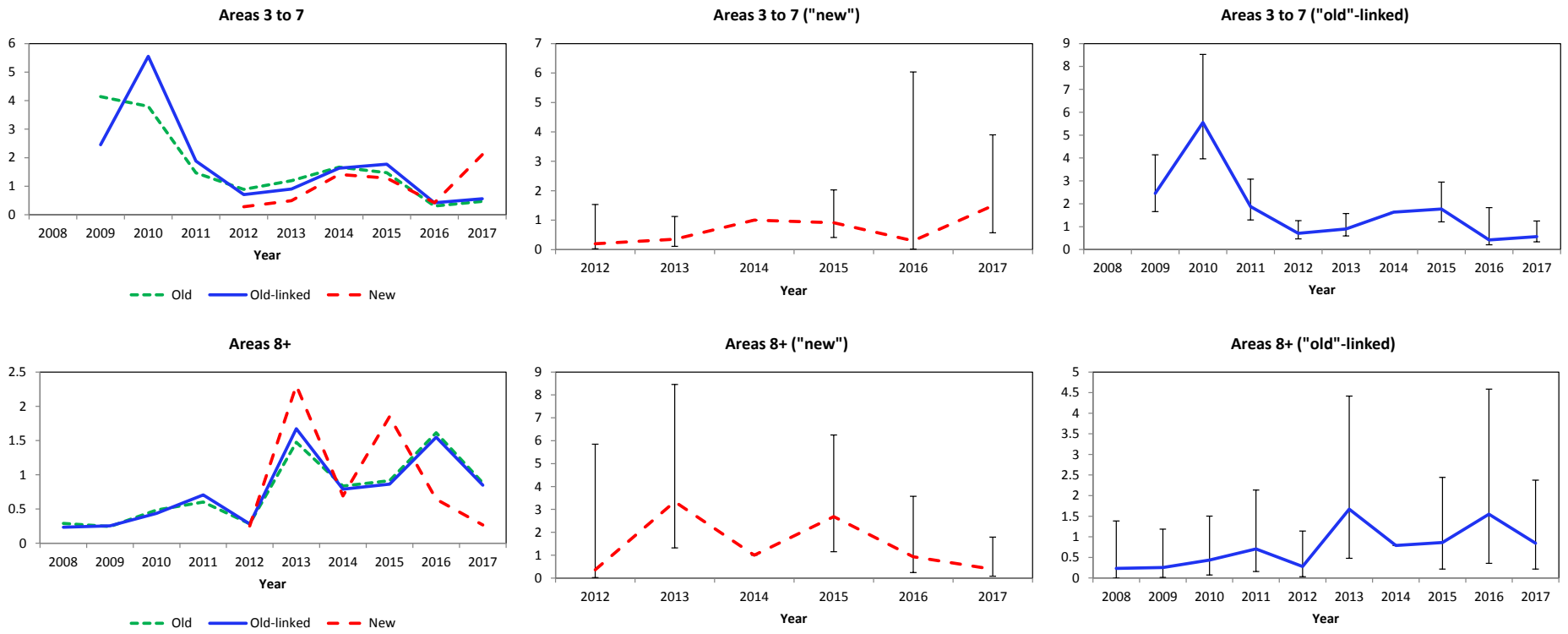

Figure 1. Year effect (together with 95% confidence limits, middle plots) for confiscations for the "new" database (right) and the comparison of poaching trends (left) obtained from the "old" database and the "old" database using relative effort efficiencies from the "new" database model ("old"-linked) (together with 95% confidence limits, plots on the right hand side) for the northern Super-areas 3+4+5+6+7 and the southern Super-area 8+. The series plotted on the left hand side have been normalised to the period 2012 to 2017 for which they overlap.

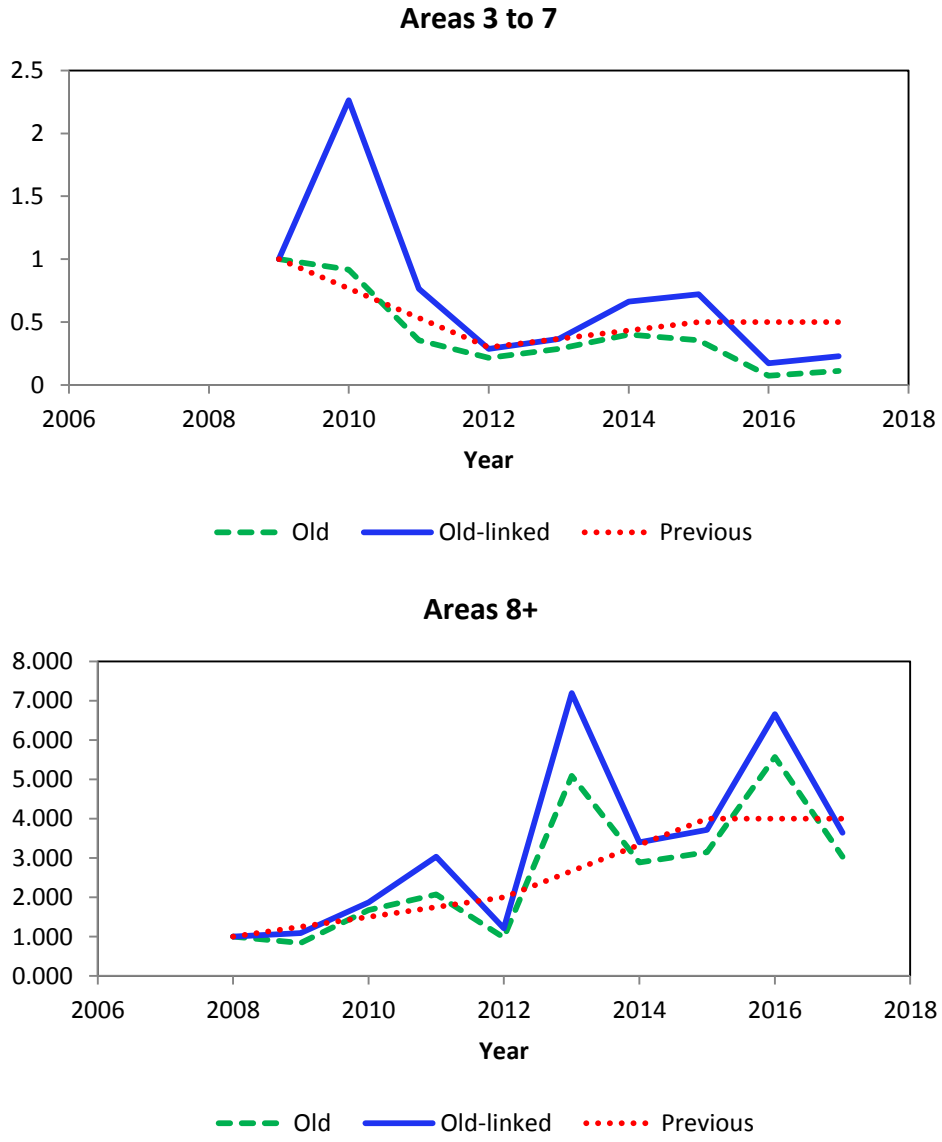

Figure 2. Poaching trends (left) obtained from the "old" database and the "old" database using relative effort efficiencies from the "new" database model ("old"-linked) for Super-areas 3+4+5+6+7 (top) and Super-area 8+ (bottom) with WCRL SWG agreements on the poaching trends as assumed for the 2016 assessment ("Previous"). Results shown are normalised to 2008=1 for Super-area 8+ or to 2009=1 for Super-areas 3+4+5+6+7 as assumed for that previous assessment and projections.

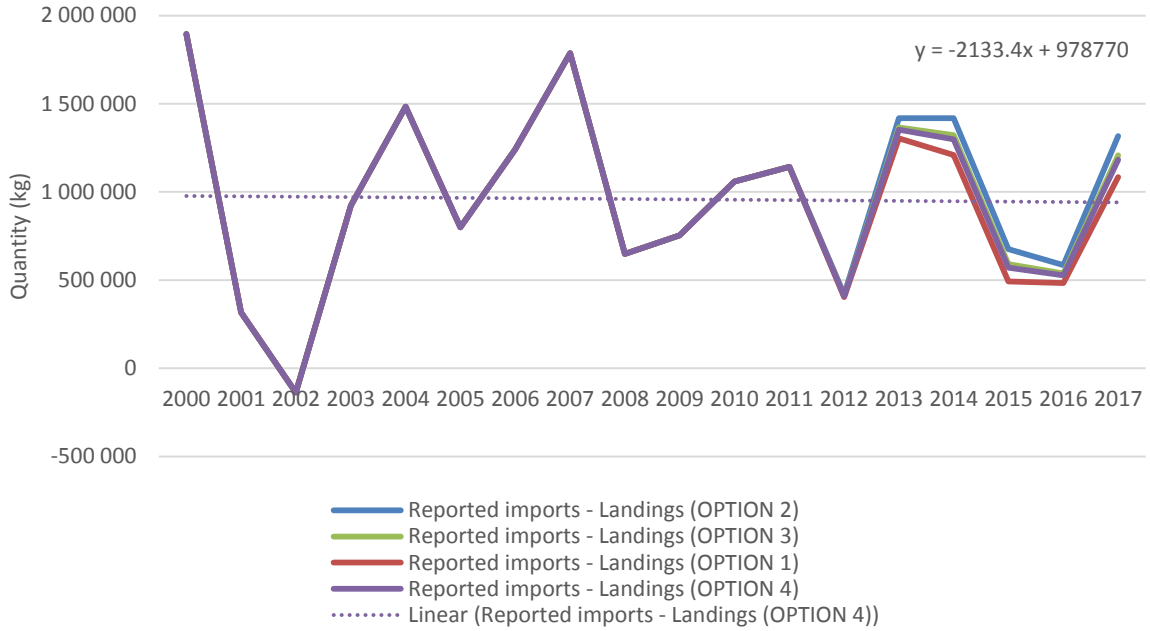

Figure 3a. Estimates of poached lobster obtained from TRAFFIC, showing all options for approximating missing country import data, and the linear regression for option 4, 2000 – 2017. The TG agreed to adopt option 4 as the most realistic. Details of these options are given in (Oakes and Burgener 2018).

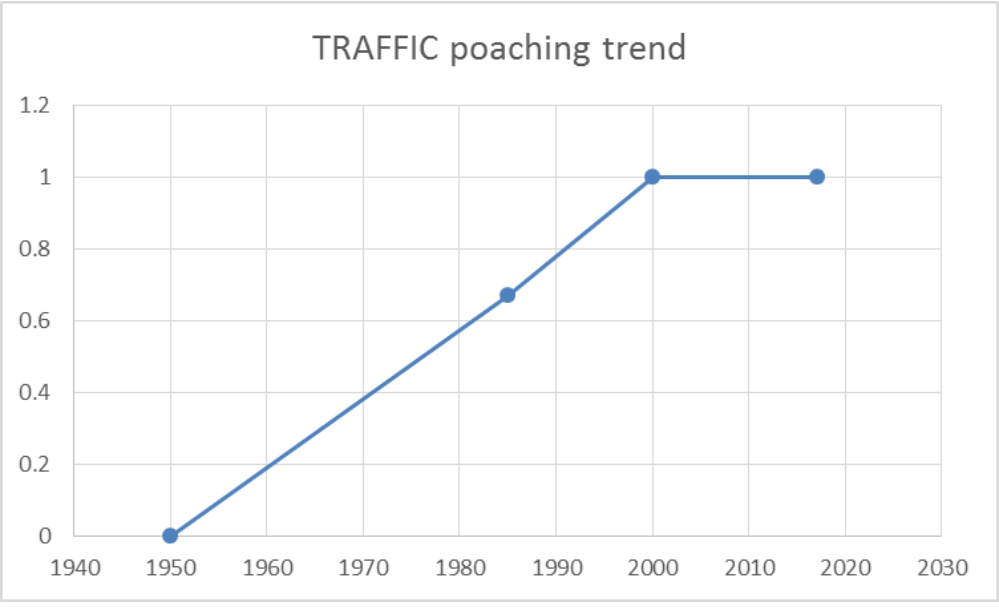

Figure 3b. Poaching trends obtained from the TRAFFIC data shown above in Figure 3a and the further assumption set out in the text. Results shown are normalised to 2000=1.

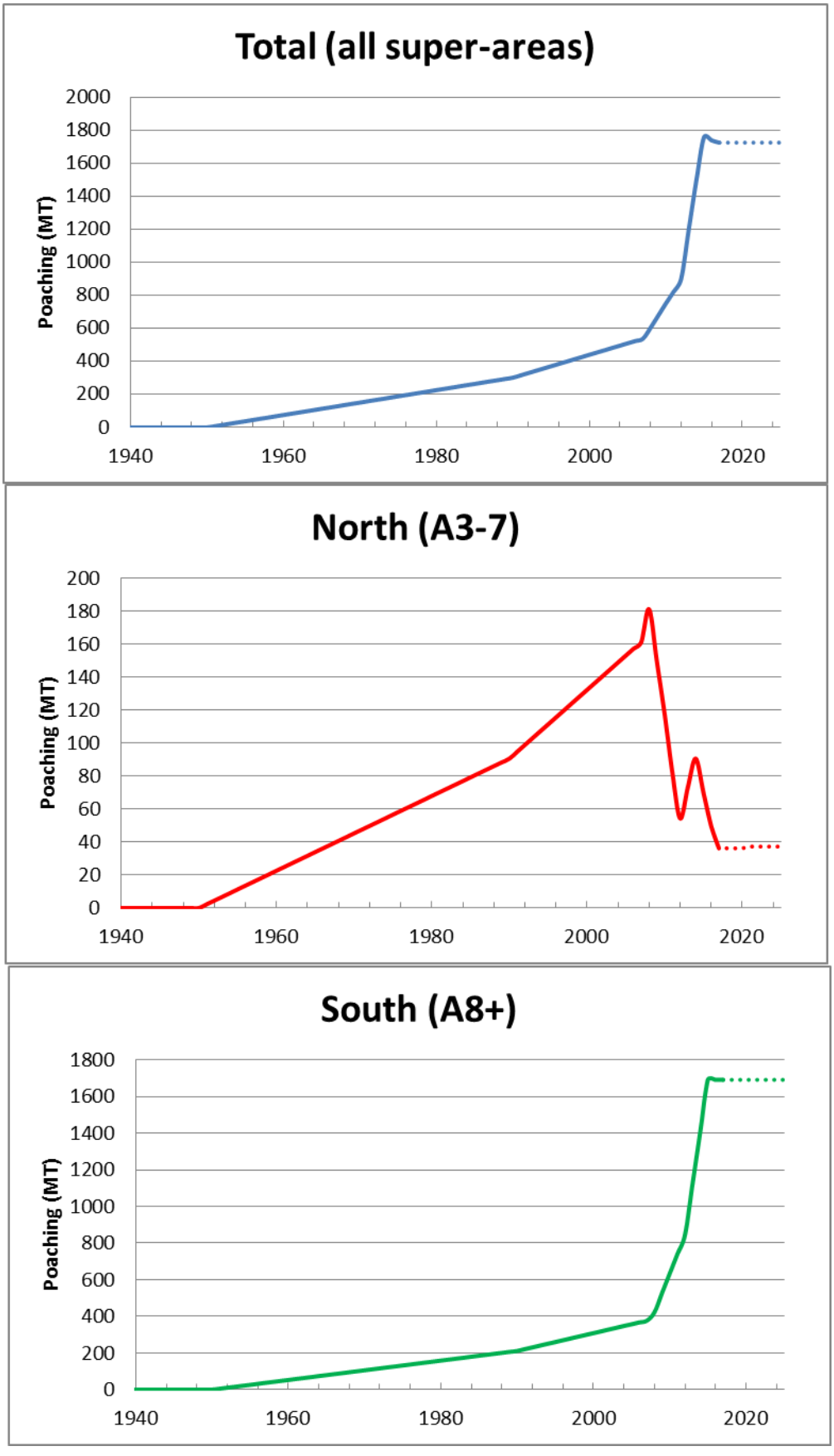

Figure 4. Poaching trends for the Compliance scenario.

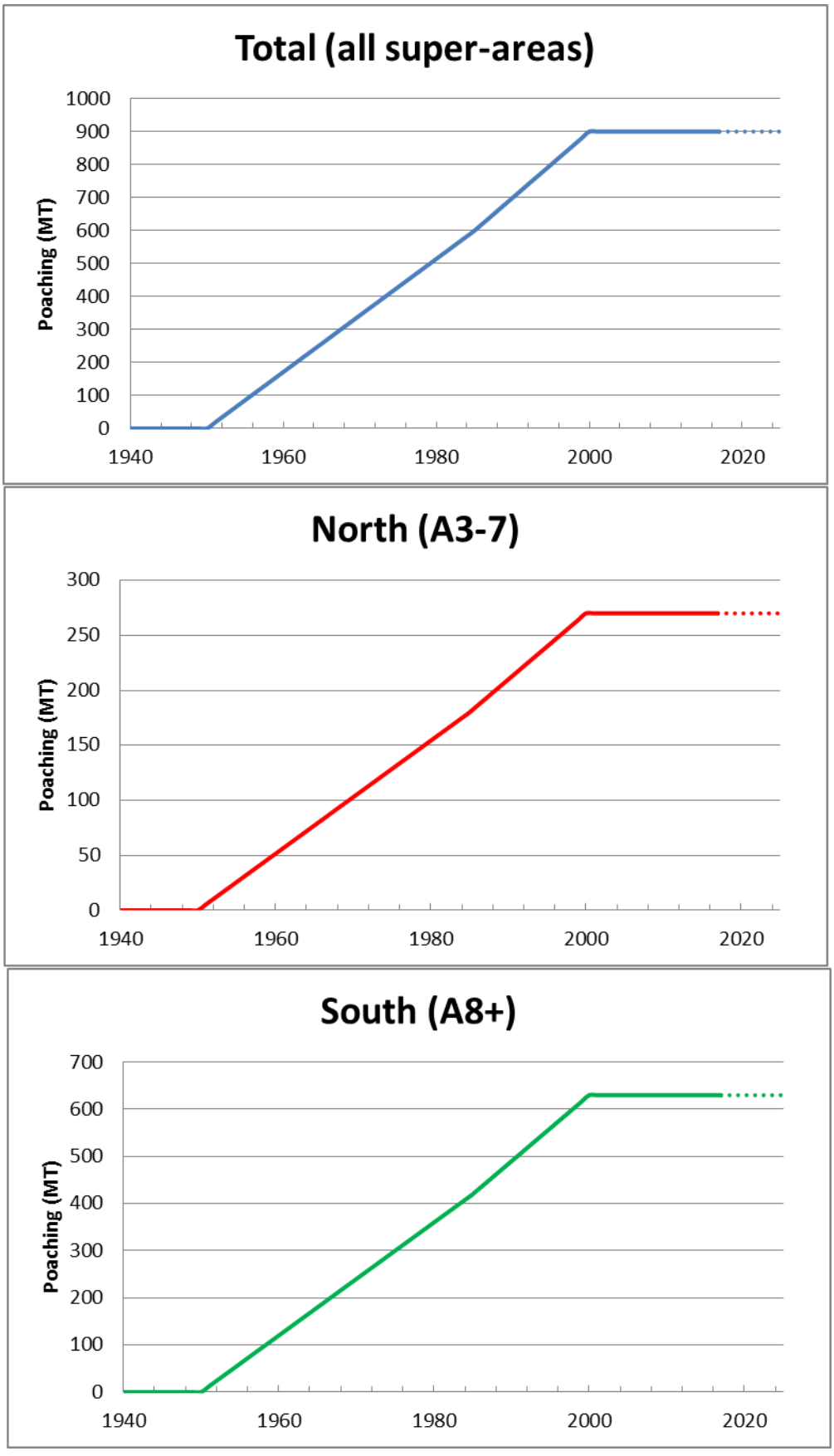

Figure 5. Poaching trends for the TRAFFIC scenario.

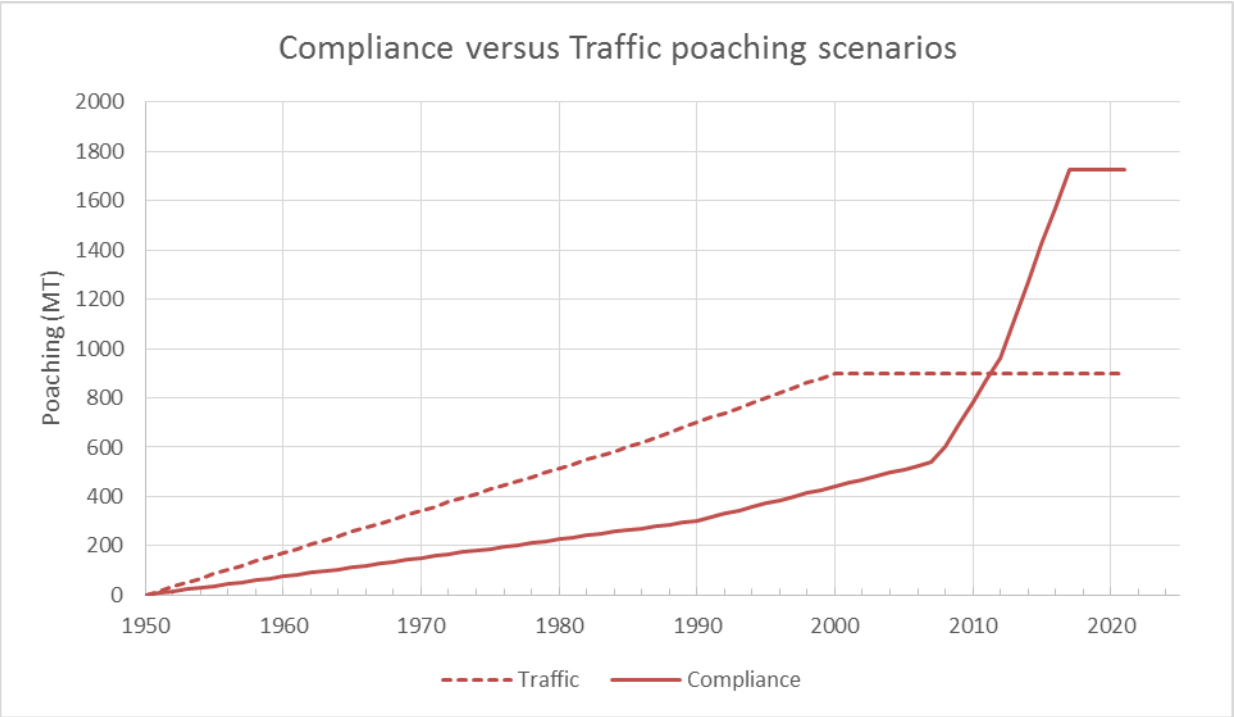

Figure 6. Comparison between the Compliance and Traffic poaching scenarios for the resource as a whole (Super-areas 3 to 8+).

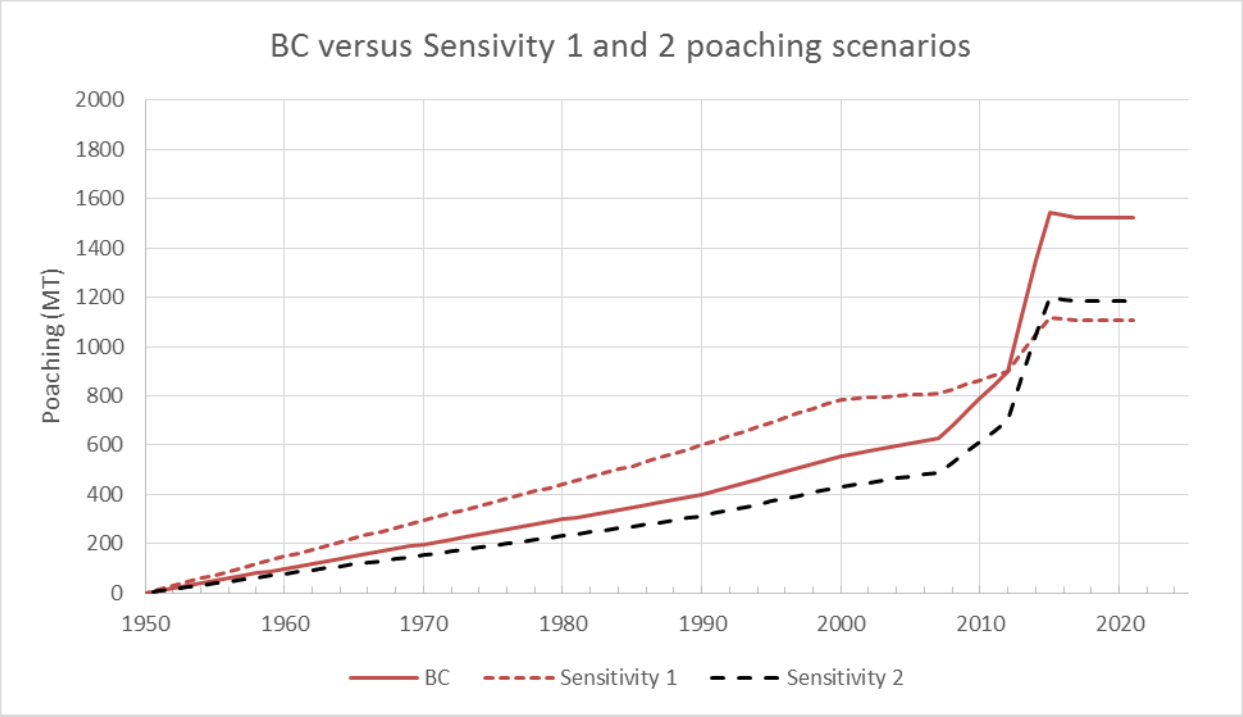

Figure 7. Plots of the Base Case (BC) and two sensitivity poaching trends proposed by the TG for use in updated assessments.